

## CLAIMS

- 1    1. A method for distributing parity across a disk array, the method comprising the steps  
2    of:
  - 3       adding a new disk to pre-existing disks of the array;
  - 4       dividing each disk into blocks, the blocks being organized into stripes such that  
5       each stripe contains one block from each disk; and
  - 6       distributing parity among blocks of the new and pre-existing disks without recal-  
7       culation or moving of any blocks containing data.
- 1    2. The method of Claim 1 wherein the step of distributing comprises the step of distrib-  
2       uting parity among blocks of the new and pre-existing disks in a manner that maintains a  
3       fixed pattern of parity blocks among stripes of the disks.
- 1    3. The method of Claim 1 wherein the step of distributing comprises the step of changing  
2       an assignment for one or more blocks containing parity of each pre-existing disk to the  
3       newly added disk.
- 1    4. The method of Claim 2 wherein the step of adding comprises the step of initializing  
2       the added disk so as to not affect parity of the stripes.
- 1    5. The method of Claim 4 wherein the step of initializing comprises the step of reas-  
2       signing blocks containing parity in certain stripes to the new disk without calculation or  
3       writing of parity.
- 1    6. The method of Claim 5 wherein the certain stripes comprise  $1/N$  of the stripes, where  
2       N is equal to the number of disks in the array.

- 1    7. The method of Claim 5 wherein the step of reassigning comprises the step of chang-
- 2    ing a block containing parity (parity block) to a block containing data (data block) and
- 3    not changing a data block to a parity block.
  
- 1    8. The method of Claim 1 wherein the step of distributing comprises the step of reas-
- 2    signing one of N blocks containing parity (parity blocks) from each pre-existing disk to
- 3    the added disk, wherein N is equal to the number of disks in the array.
  
- 1    9. The method of Claim 8 wherein the step of reassigning comprises the step of reas-
- 2    signing one of N parity blocks to the new disk, with each pre-existing disk continuing to
- 3    hold 1/N of the parity blocks in the array.
  
- 1    10. A system adapted to distribute parity across disks of a storage system, the system
- 2    comprising:
  - 3       a disk array comprising pre-existing disks and at least one new disk; and
  - 4       a storage module configured to compute parity in blocks of stripes across the
  - 5       disks and reconstruct blocks of disks lost as a result of failure, the storage module further
  - 6       configured to assign the parity among the blocks of the new and pre-existing disks with-
  - 7       out recalculation or moving of any data blocks.
  
- 1    11. The system of Claim 10 further comprising a table configured to store parity assign-
- 2    ments calculated for one of a known group size of the disk array and a maximum group
- 3    size of the array, the stored parity assignments defining a repeat interval of a parity distri-
- 4    bution pattern used to determine locations of parity storage on any disk in the array.
  
- 1    12. The system of Claim 10 wherein the storage module is embodied as a RAID system
- 2    of the storage system.

- 1    13. The system of Claim 10 wherein the storage module is embodied as an internal disk array controller of the storage system.
- 1    14. The system of Claim 10 wherein the storage module is embodied as a disk array control system externally coupled to the storage system.
- 1    15. The system of Claim 10 wherein the disk array is a block-based RAID array.
- 1    16. A method for distributing commodities over containers of a system, the method comprising the steps of:
  - 3       adding a new container to pre-existing containers of the system to thereby provide
  - 4        $N$  containers; and
  - 5       moving only  $1/N$  of the commodities to the new container.
- 1    17. The method of Claim 16 wherein the system is a storage system, the commodities are data structures adapted for storage on storage devices of an array, and the containers are storage entities coupled to the array.
- 1    18. The method of Claim 17 wherein the storage entities are storage heads.
- 1    19. The method of Claim 17 wherein the data structures are inode file blocks.
- 1    20. Apparatus for distributing parity across a disk array, the apparatus comprising:
  - 2       means for adding a new disk to pre-existing disks of the array;
  - 3       means for dividing each disk into blocks, the blocks being organized into stripes
  - 4       such that each stripe contains one block from each disk; and
  - 5       means for distributing parity among blocks of the new and pre-existing disks
  - 6       without recalculation or moving of any blocks containing data.

- 1    21. A computer readable medium containing executable program instructions for distrib-
- 2    uting parity across a disk array, the executable instructions comprising one or more pro-
- 3    gram instructions for:
  - 4       adding a new disk to pre-existing disks of the array;
  - 5       dividing each disk into blocks, the blocks being organized into stripes such that
  - 6       each stripe contains one block from each disk; and
  - 7       distributing parity among blocks of the new and pre-existing disks without recal-
  - 8       culation or moving of any blocks containing data.